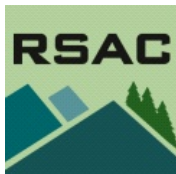
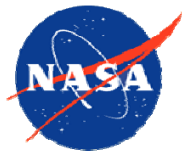


# Contribution of Near Real Time MODIS-Based Forest Disturbance Detection Products to a National Forest Threat Early Warning System

Presented to the 2011 AGU Fall Meeting by:  
Joseph Spruce, Computer Sciences Corporation (CSC)  
William Hargrove, USDA Forest Service  
Gerald Gasser, Lockheed Martin  
James Smoot, CSC  
Philip Kuper, CSC



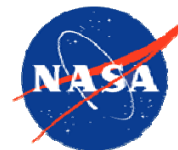
# Introduction



- U.S. forests occupy ~751 million acres (~1/3 of total land)
- These forests are exposed to multiple biotic and abiotic threats that collectively damage extensive acreages each year
- Hazardous forest disturbances can threaten human life and property, bio-diversity and water supplies
- Timely regional forest monitoring products are needed to aid forest management and decision making by the US Forest Service and its state and private partners
- Daily MODIS data products provide a means to monitor regional forest disturbances on a weekly basis
- In response, we began work in 2006 to develop a Near Real Time (NRT) forest monitoring capability, based on MODIS NDVI data, as part of a national forest threat early warning system (EWS)

# Driver for the EWS: Healthy Forest Restoration Act of 2003

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- The EWS was mandated by the Healthy Forest Restoration Act (HFRA) of 2003, Section VI
  - *“In carrying out the program, the Secretary (of Agriculture) shall develop a comprehensive early warning system for potential catastrophic environmental threats to forests”*
- Threats include those from insects, diseases, invasive species, fire, weather-related risks and other episodic events, as well as forest loss and degradation
- The HFRA discusses the EWS as part of a forest inventory and monitoring program to improve detection and response to environmental threats
- The EWS is to provide timely regional forest monitoring and threat assessment data for government and public use

# Objectives for 2011 NRT MODIS Forest Disturbance Detection Products

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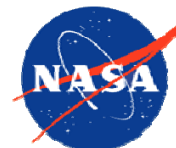


- **Objective 1** – Contribute nationwide weekly NRT MODIS %NDVI forest disturbance detecting products to USFS EWSs
  - U.S. Forest Change Assessment Viewer (FCAV)
  - U.S. Forest Disturbance Mapper (FDM)
- **Objective 2** – Conduct in-season rapid preliminary assessments of MODIS %NDVI for detecting regional forest disturbances in NRT according to:
  - Biotic damage agents
  - Abiotic damage agents
  - Forest cover types (general and specific)
  - U.S. regions
  - Seasons within calendar year

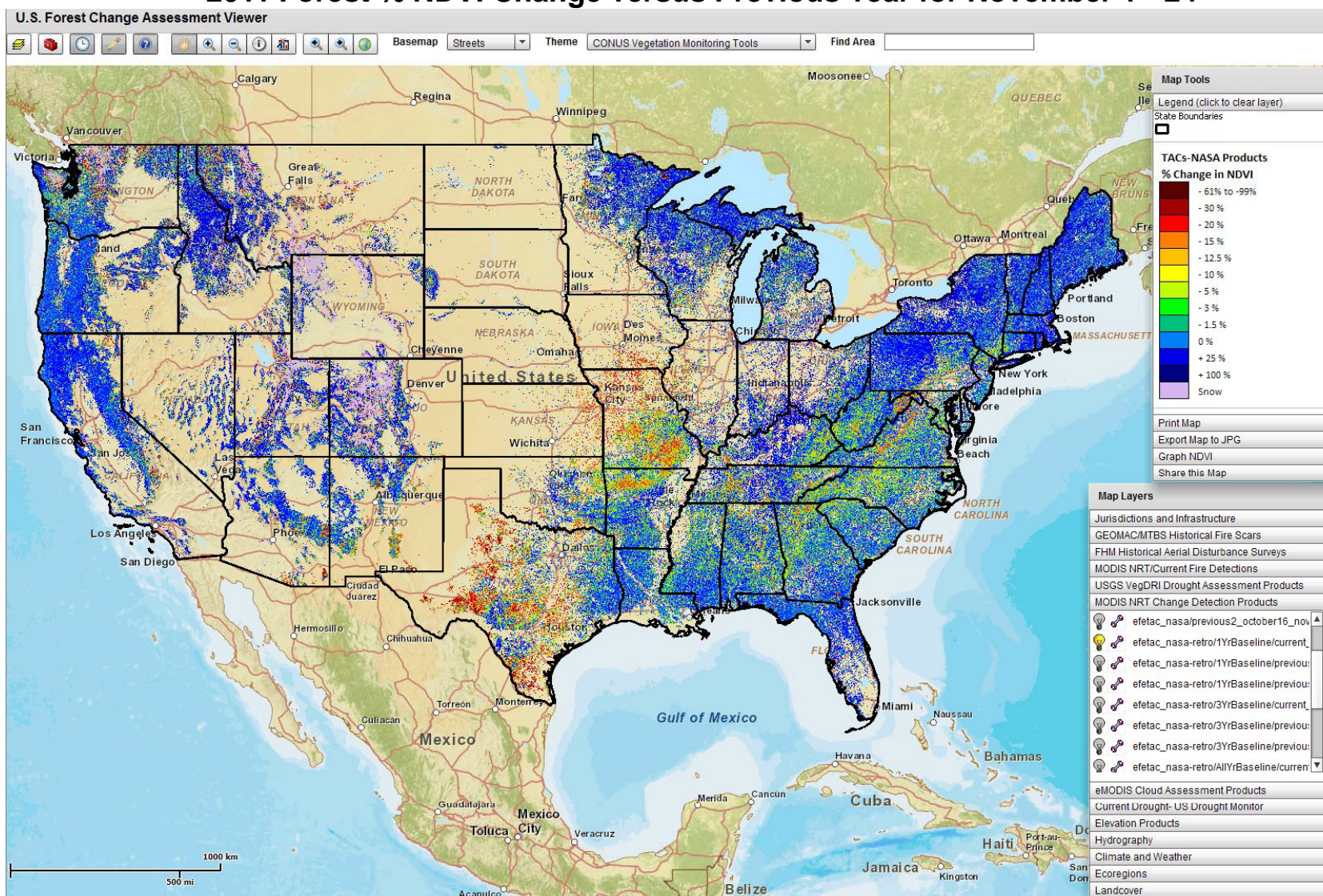


# U.S Forest Change Assessment Viewer (New Products Every 8 Days)

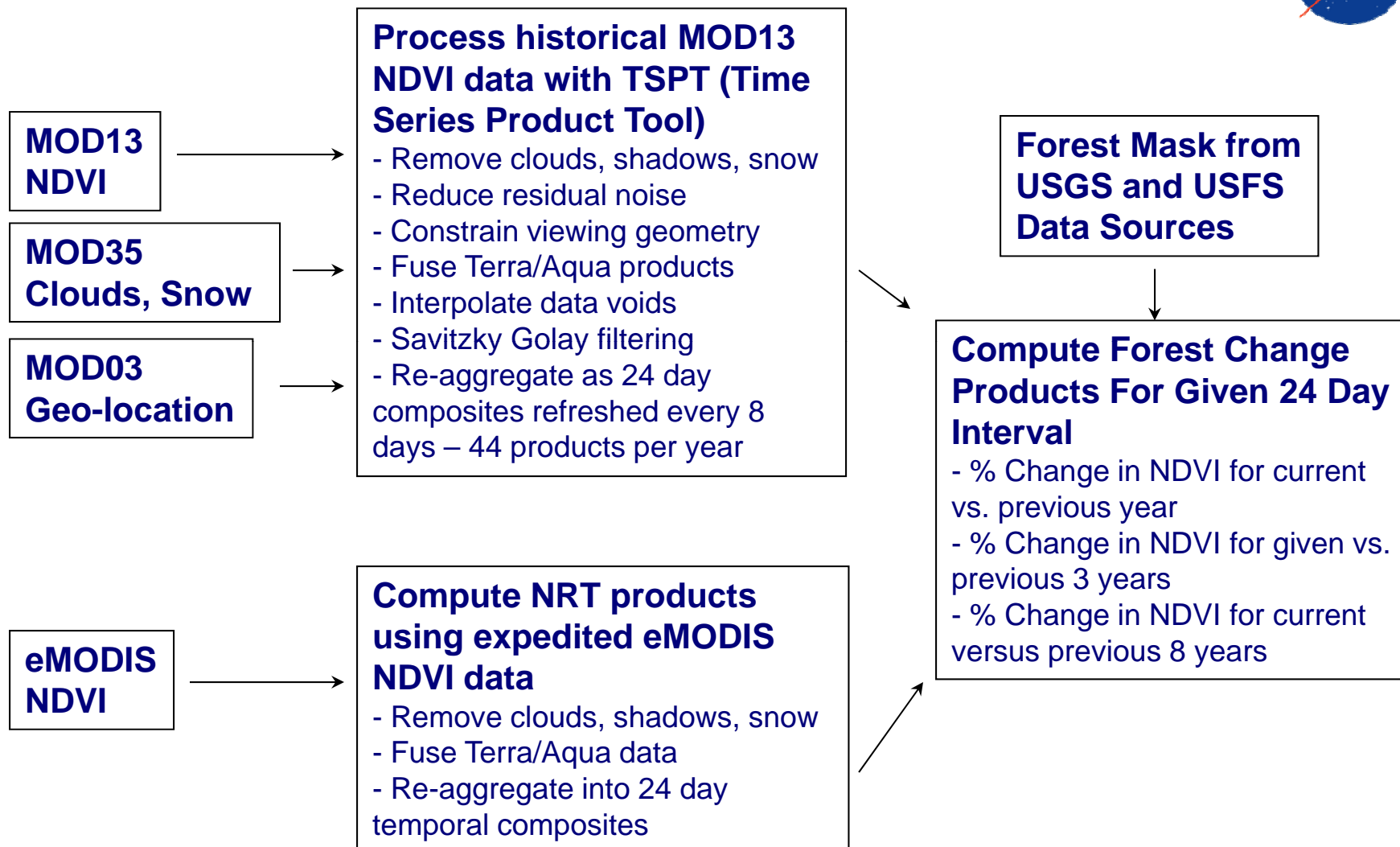
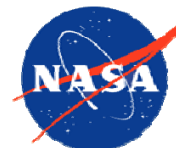
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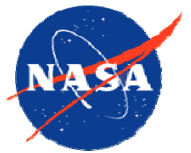


2011 Forest % NDVI Change versus Previous Year for November 1 - 24



# MODIS NDVI Processing Method





## **Series 1 – Examples of MODIS Change Products Detecting Regionally Evident Abiotic Forest Disturbances**

- April 27, 2011 tornadoes in Mississippi and Alabama
- 2011 Los Conchas fire of New Mexico
- 2011 Mississippi River flooding impacts on wetland forests of Louisiana and Mississippi
- 2011 drought in Texas and adjacent states
- All shown products were posted in NRT on the FCAV during 2011



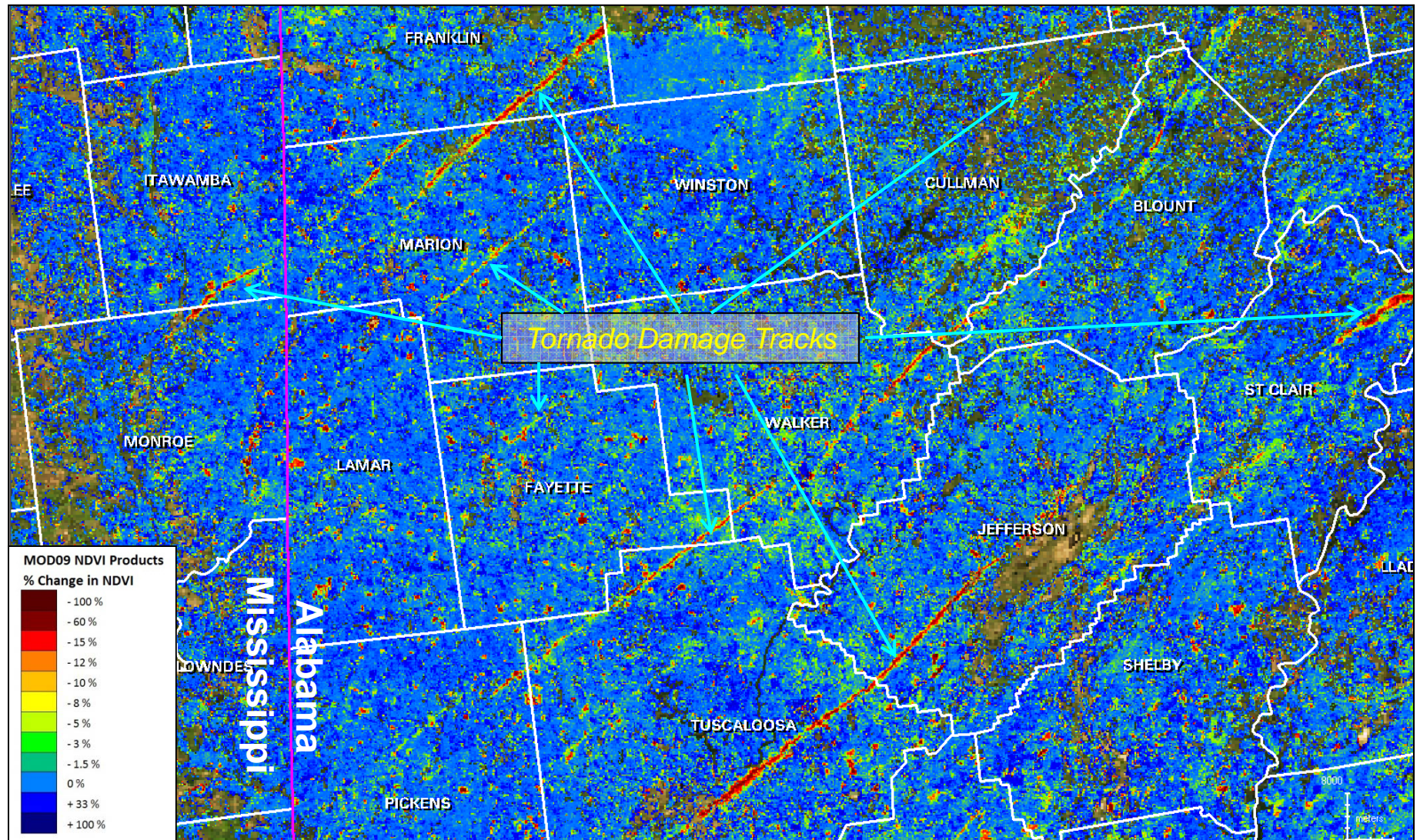
# MODIS View of April 27, 2011

## Tornadoes in Mississippi and Alabama

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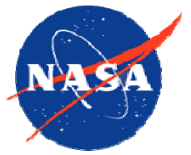
Forest %NDVI Change for May 1-24, 2011 versus 2010 – Counties in White



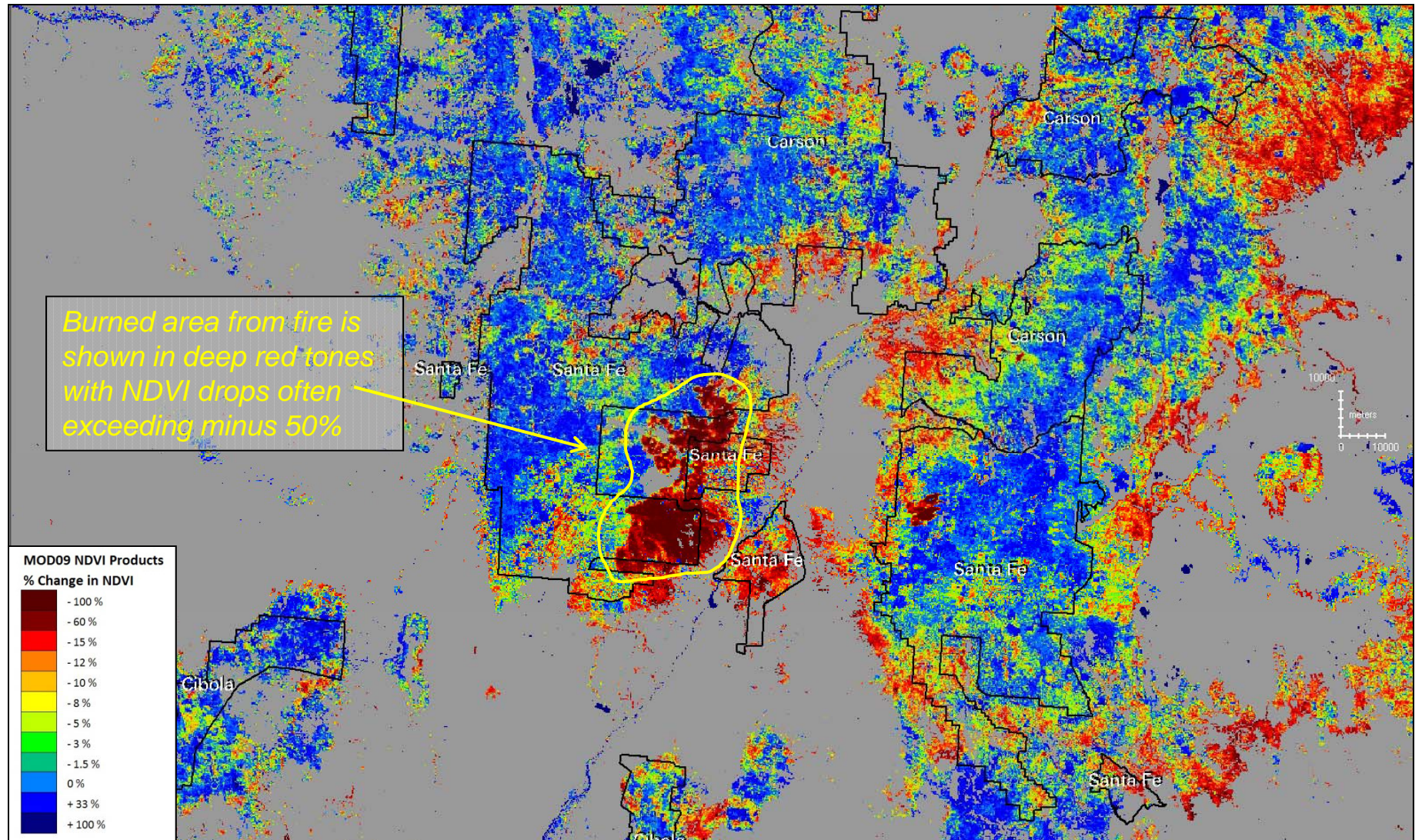


# MODIS View of 2011 Los Chonchas Fire in New Mexico

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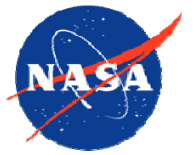
Forest %NDVI Change for August 5 – 28, 2011 versus 2010 – National Forests in Black



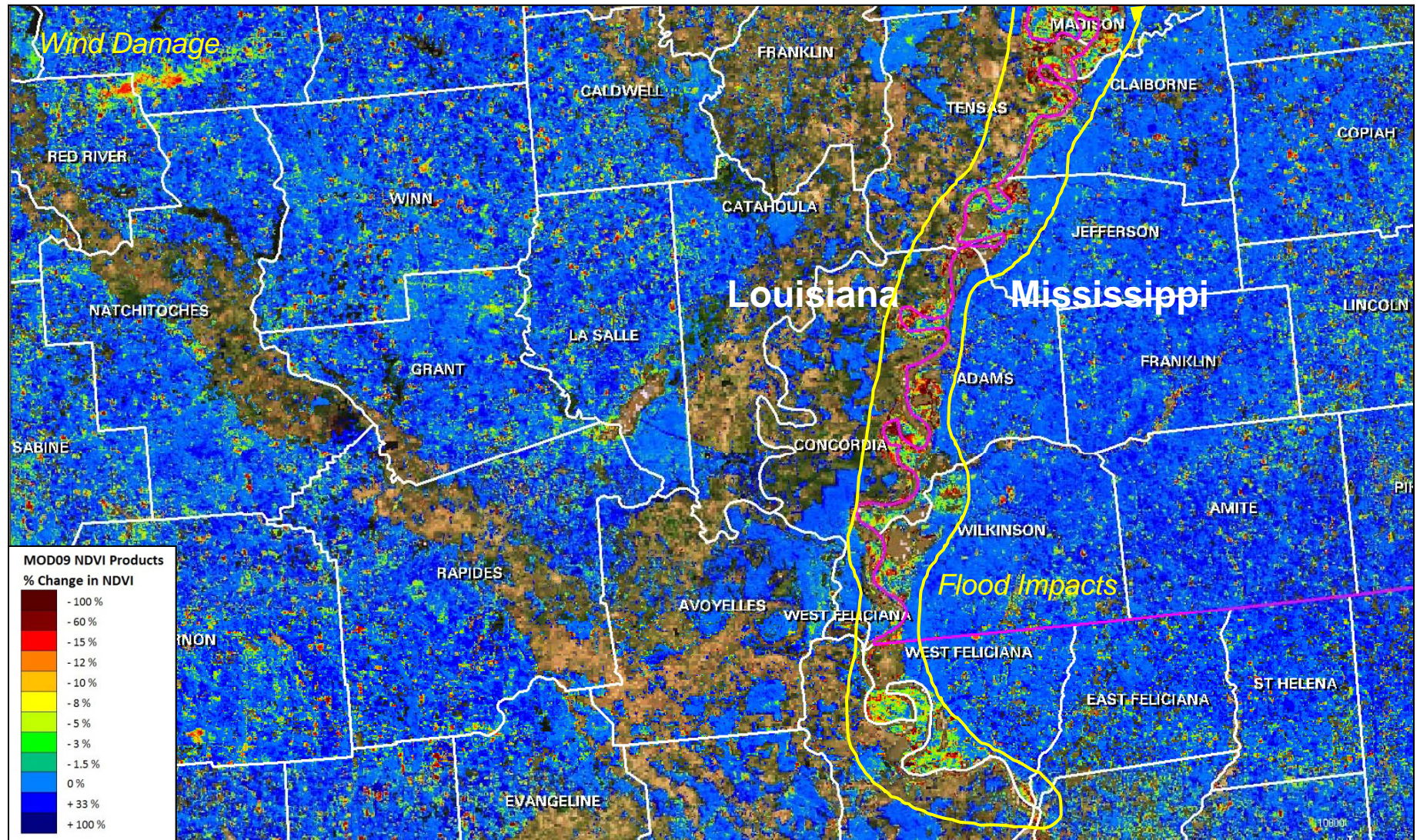


# MODIS View of Mississippi River Flooding of Wetland Forests

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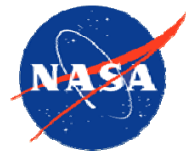
Forest %NDVI Change for May 9 through June 1 of 2011 versus 2010 – Counties in White



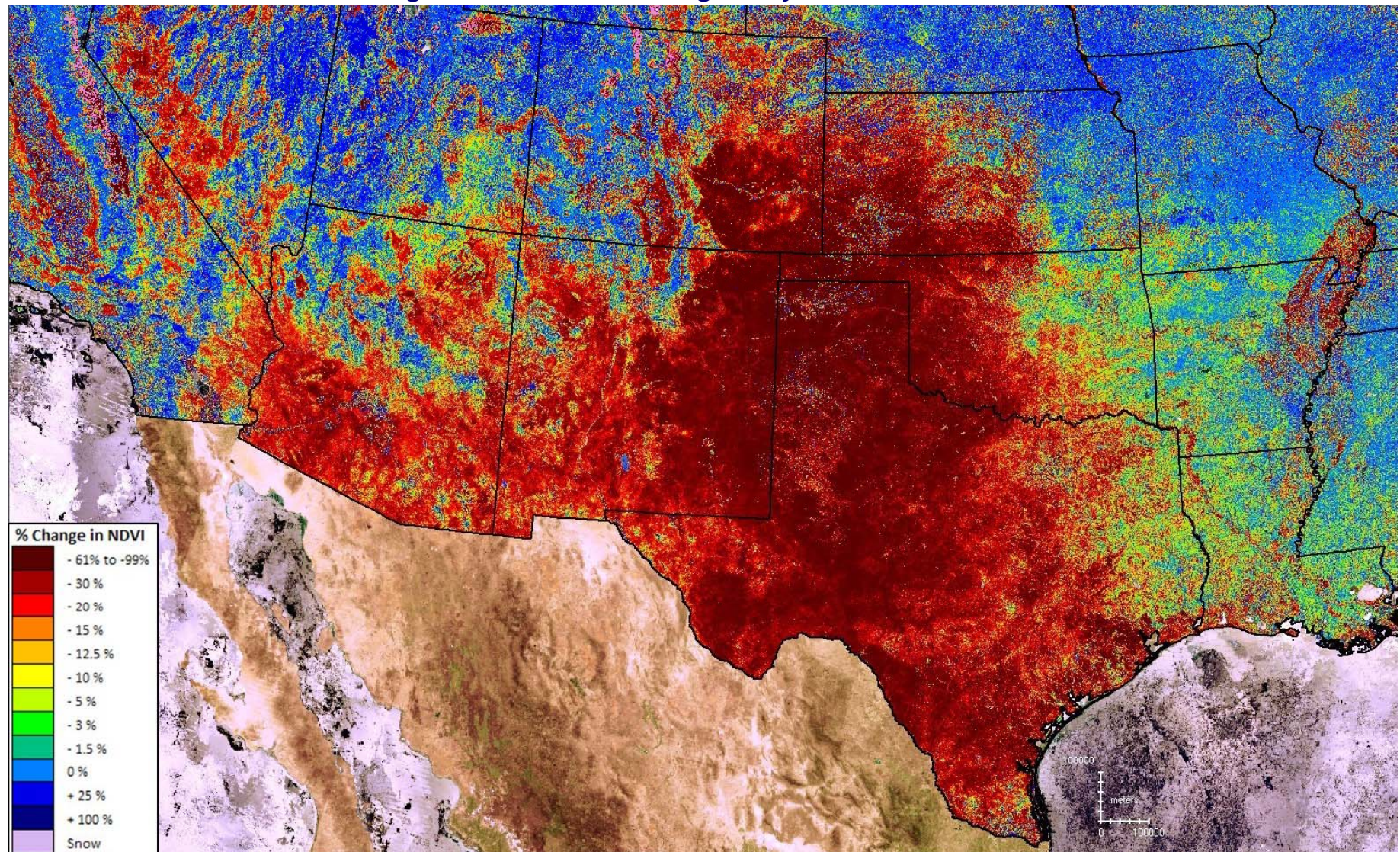


# MODIS View of 2011 Drought in Texas and Adjacent States

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*Land %NDVI Change for June 18 through July 11 of 2011 versus 2003-2010*





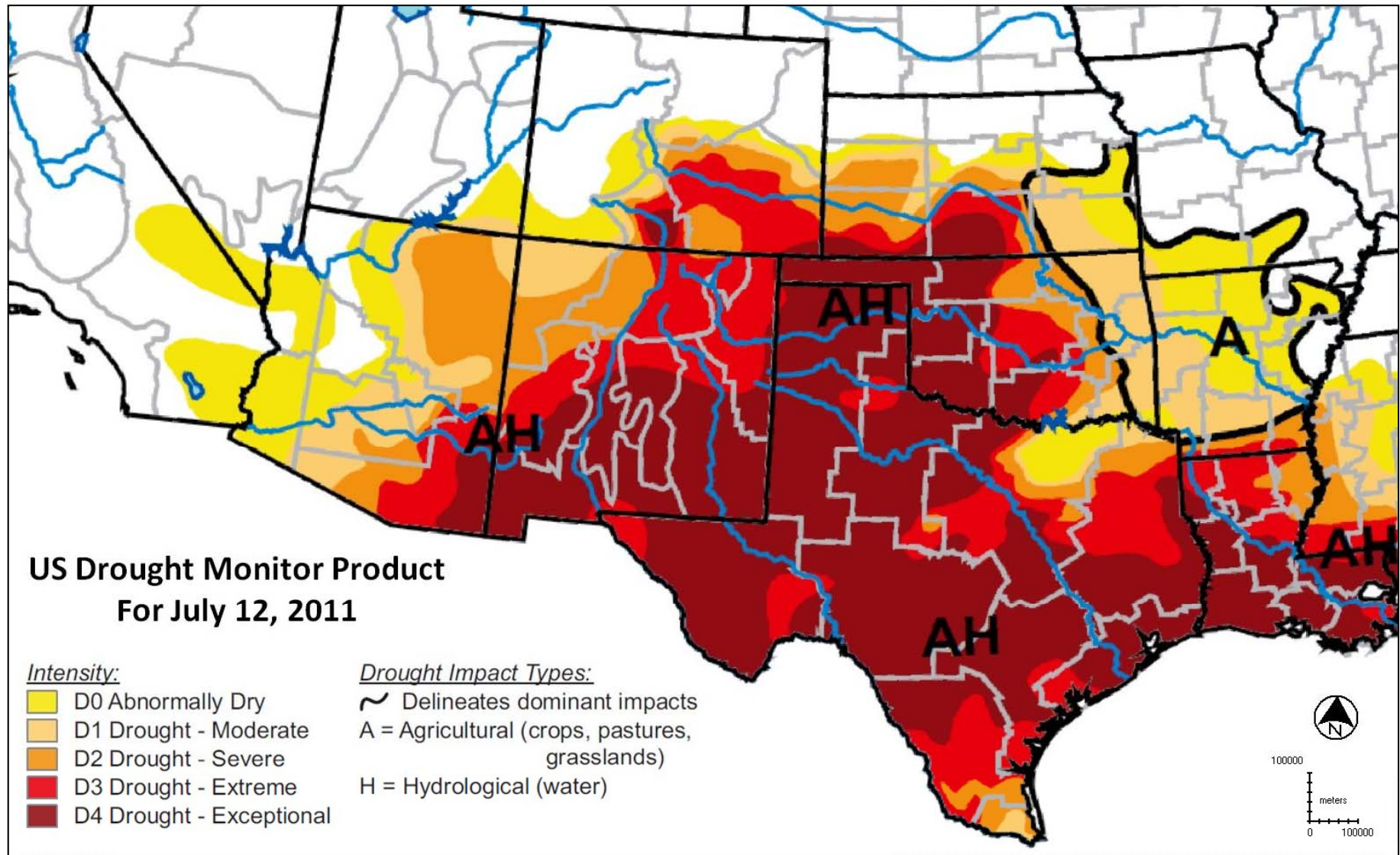
# U.S. Drought Monitor View of 2011

## Drought in Texas and Adjacent States

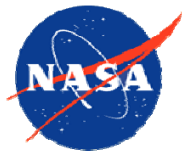
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U.S. Drought Monitor Product for July 12, 2011







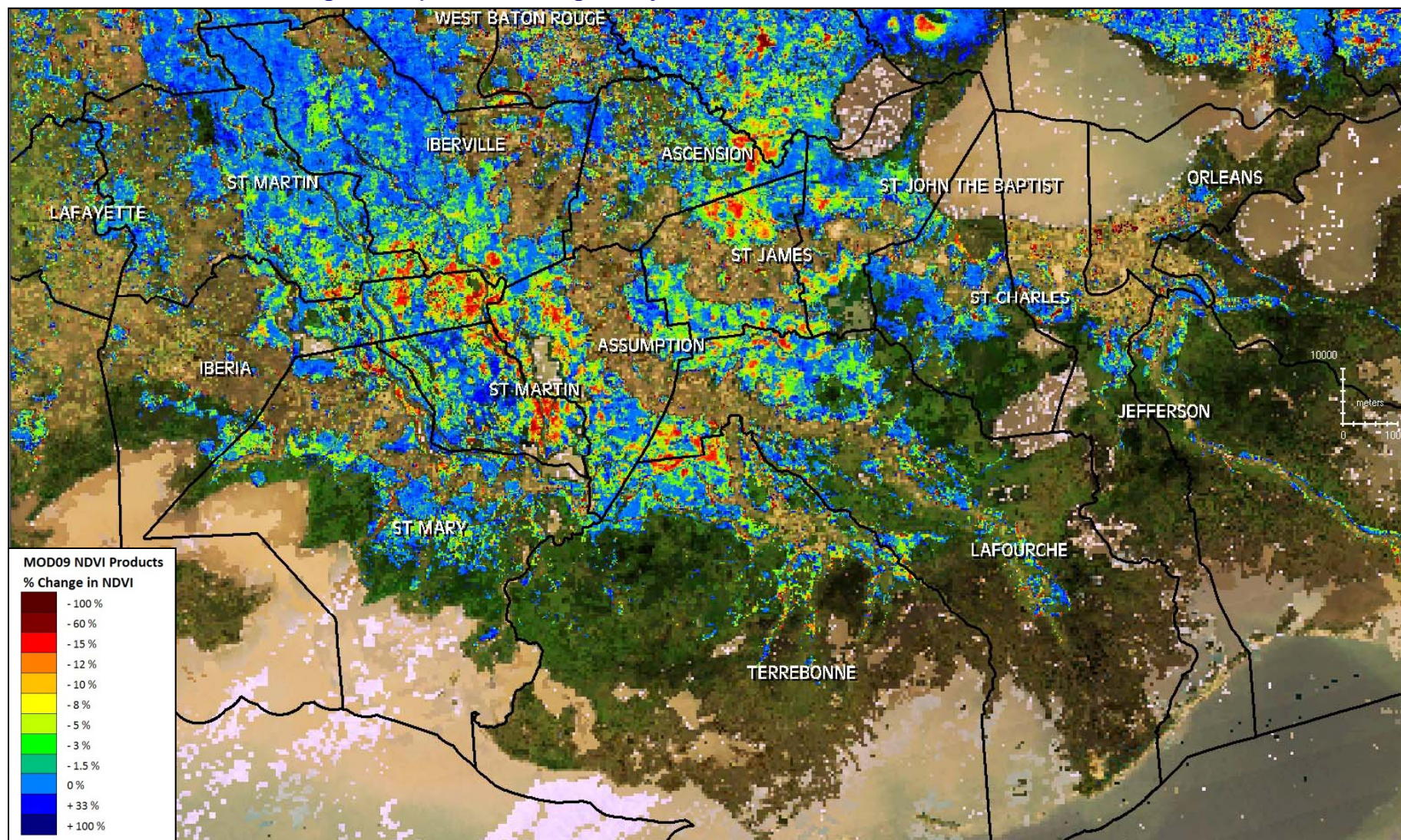
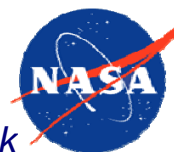
## **Series 2 – Examples of MODIS Change Products Showing Regionally Evident Biotic Forest Disturbances**

- Spring 2011 - wetland forest defoliation in Louisiana
- Summer 2011 – potential bark beetle induced forest mortality in Utah
- Summer 2011 - spruce budworm forest defoliation in Washington
- Fall 2011 - fall webworm defoliation in Pennsylvania
- All shown products were posted in NRT on the FCAV during 2011

# View of Wetland Forest Defoliation in Coastal Louisiana

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Forest %NDVI Change for April 15 through May 8 of 2011 versus 2003-2010 – Counties in Black

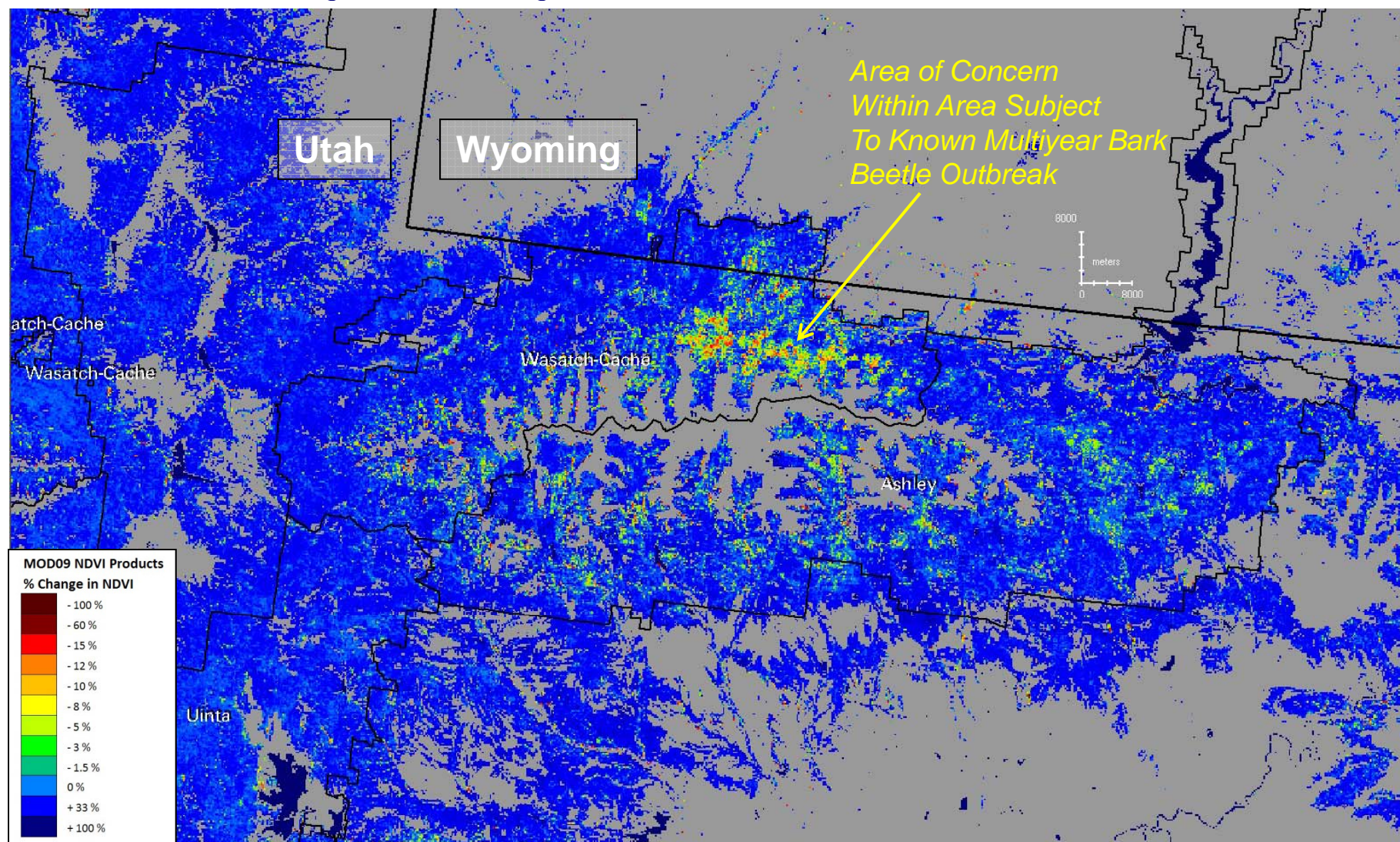
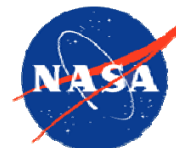




# MODIS View of Potential Expansion of Bark Beetle Mortality in Utah

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Forest %NDVI Change for 8/21 through 9/13 of 2011 versus 2010 – National Forests in Black

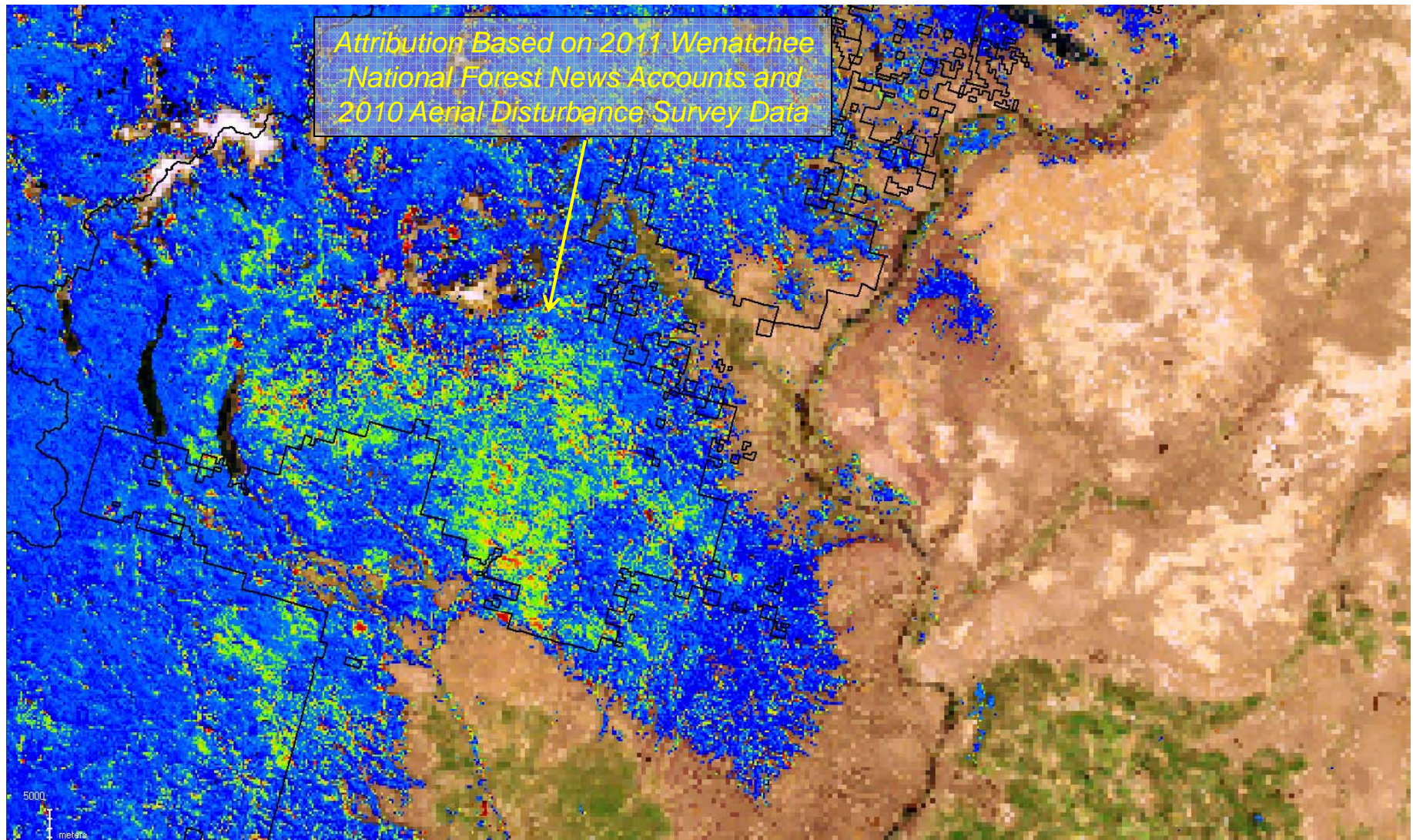
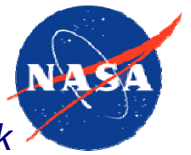




# MODIS View of Apparent Spruce Budworm Defoliation in Washington

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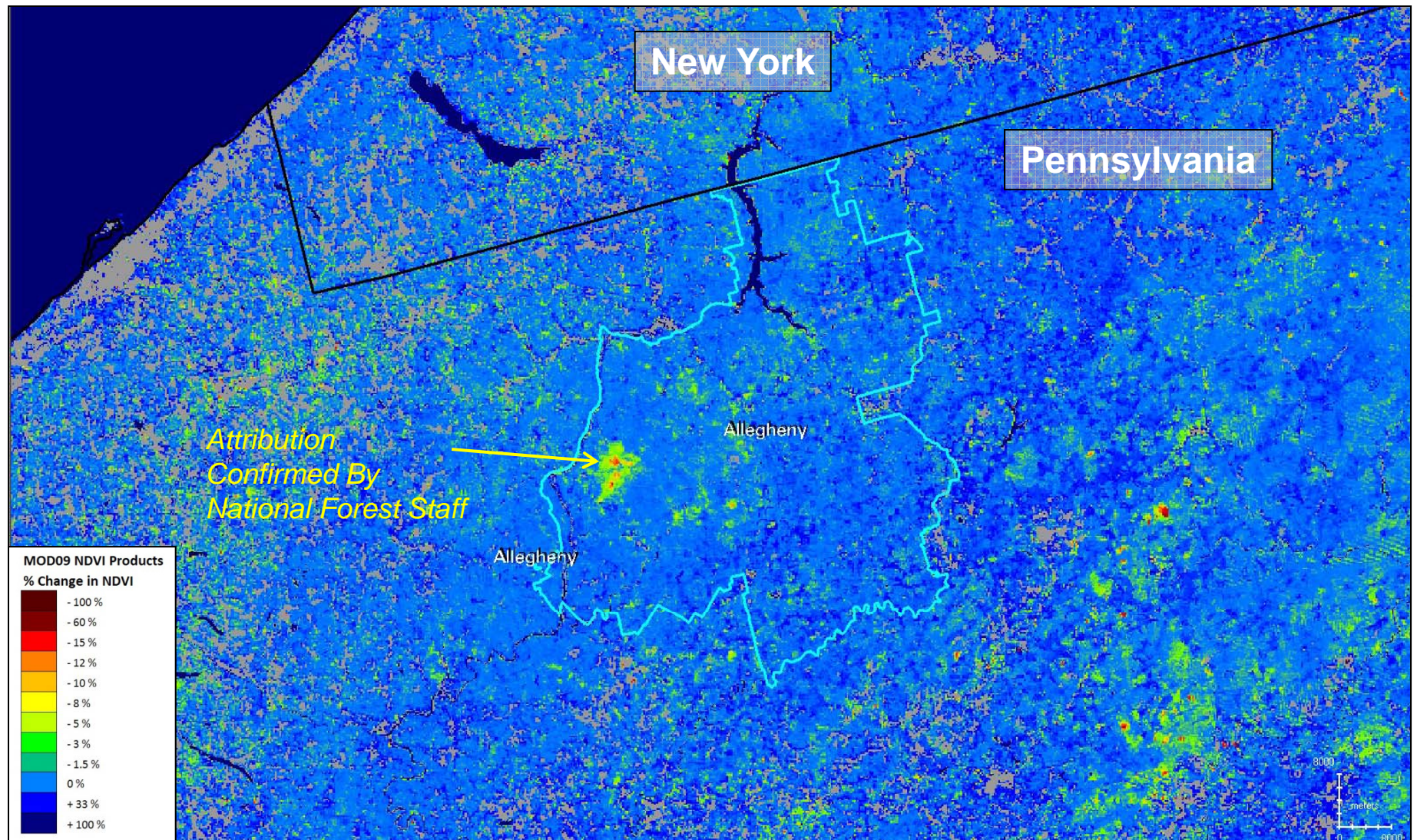
Forest %NDVI Change for 8/21 through 9/13 of 2011 versus 2008-2010 – National Forests in Black





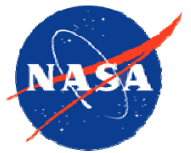
# MODIS View of Fall Webworm Defoliation in Pennsylvania

Stennis Space Center



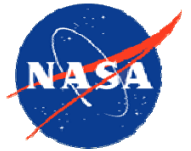


## Comments on 2011 Results



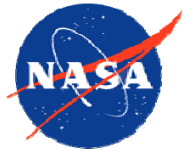
- NRT MODIS CONUS forest change products were used to detect multiple regional biotic and abiotic forest disturbances
- Recent disturbances were most readily identified on change products using the previous year NDVI as a baseline
- Longer multiyear NDVI baselines were useful for assessing insect defoliation, as well as chronology, persistence, and duration of multiyear disturbance events
- News accounts, aerial disturbance surveys, fire maps, and Landsat data were used to evaluate apparent forest disturbances
- Forest disturbance detection can depend on the damage agent, season, and location
- Improved snow masks aided change product interpretability

## Final Remarks



- The 2011 NRT MODIS % NDVI change products in the FCAV enabled regional forest monitoring across the U.S.
- Regional disturbance events observed on these products tended to show visual agreement with reference data
- Weekly change products were contributed to the FCAV and FDM with typical latencies of 1-2 days after the last collection date
- Future work will include additional product automation, validation, testing alternative historical baseline methods, and improving MODIS true color composite products
- The FCAV can be viewed on-line at [ews.forestthreats.org/gis/ews\\_gis.htm](http://ews.forestthreats.org/gis/ews_gis.htm)
- For additional information, email [joseph.p.spruce@nasa.gov](mailto:joseph.p.spruce@nasa.gov)

# Project Publications



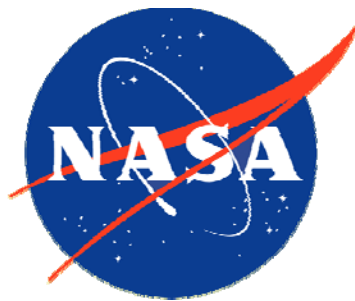
W.W. Hargrove, J.P. Spruce, G.E. Gasser, and F.M. Hoffman, 2009, Toward a national early warning system for forest disturbances using remotely sensed canopy phenology. *Photogrammetric Engineering & Remote Sensing* 75:1150-1156.

McKellip, R., D. Prados, R. Ryan, K. Ross, J. Spruce, G. Gasser, and R. Greer, 2008: Remote-sensing time series analysis, a vegetation monitoring tool, *NASA Tech Briefs* 32(4):63-64.

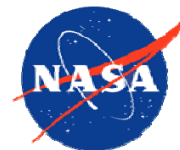
Ramsey E., J. Spruce, A. Rangoonwala, Y. Suzuoki, J. Smoot, and J. Gasser, and T. Bannister, 2011: Daily MODIS data trends of hurricane-induced forest impact and early recovery, *Photogrammetric Engineering and Remote Sensing*, 77 (11):133-143.

Spruce, J.P., S. Sader, R. E. Ryan, J. Smoot, P. Kuper, K. Ross, D. Prados, J. Russell, G. Gasser, R. McKellip, and W. Hargrove, 2011, Assessment of MODIS NDVI time series data products for detecting forest defoliation from gypsy moth outbreaks, *Remote Sensing of Environment*, 115:427–437.



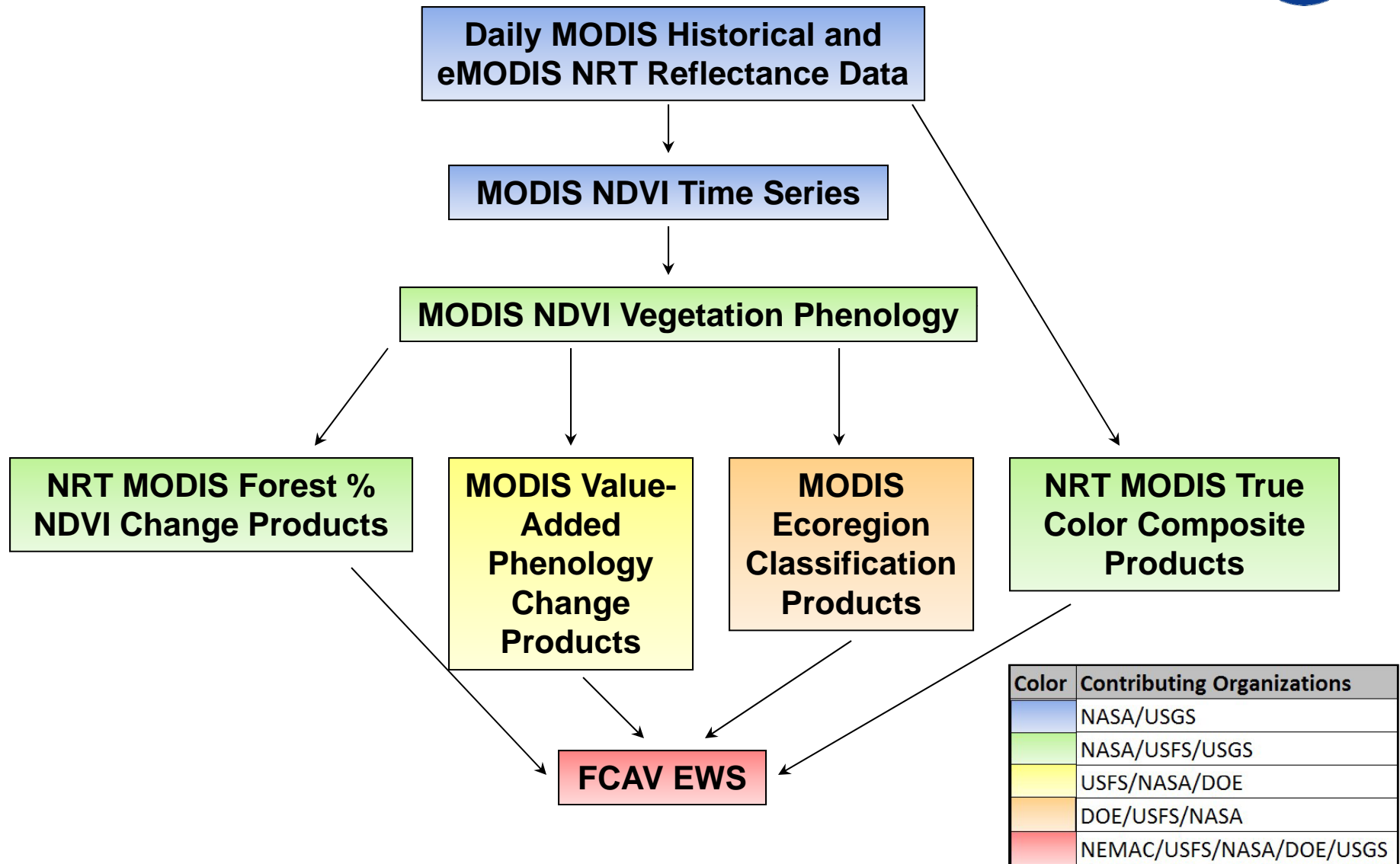


*Participation in this work by Computer Sciences Corporation, Inc., was supported by NASA at the John C. Stennis Space Center, Mississippi, under contract NNS10AA35C. Project funding was provided to NASA by the USDA Forest Service Eastern and Western Threat Assessment Centers.*



# Extra Slides

# MODIS Products for FCAV EWS Use



# Product Development History



- 2006-2008
  - Conducted R&D to compute regional forest monitoring products
  - Began computing CONUS MODIS vegetation phenology products
  - Performed retrospective regional forest disturbance detection studies, based on MODIS NDVI phenology products
- 2009
  - Began NRT regional forest disturbance detection studies
  - Published PE&RS highlight article on initial NRT results
- 2010-2011
  - Weekly NRT CONUS forest disturbance detection products posted on multiple USFS prototypical EWS web mapping services, including the U.S. Forest Change Assessment Viewer (FCAV)
  - RSE publication - initial retrospective case study on use of MODIS NDVI for detecting regional forest defoliation from gypsy moths